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We don't have language at our house: Disentangling the relationship between phonological awareness, schooling, and literacy

K.J. Alcock[1,2], D. Ngorosho[2], C. Deus[2] and M.C.H. Jukes[2, 3]

[1]Lancaster University
[2] MAKWAMI Project, Bagamoyo, Tanzania
[3]Harvard University

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*Requests for reprints should be addressed to Katie Alcock, Department of Psychology, Fylde College, Lancaster University, Lancaster, LA1 4YF, UK (e-mail: k.j.alcock@lancaster.ac.uk).

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This paper is dedicated to the memory of Charles Deus.

Abstract

Background: A strong link between phonological awareness (PA) and literacy exists, but the origins of this link are difficult to investigate, since PA skills are hard to test in young, pre-literate children, and many studies neither include such children nor report children's initial literacy levels.

Aims: To examine PA and literacy in children who are attending or not attending school in rural East Africa.

Sample: 108 children ages 7 to 10 years, with no education, or in grades 1 or 2, randomly selected from a community survey of all children in this age group.

Methods: PA skill, reading, cognitive abilities and socio-economic status were examined.

Results: Implicit and explicit PA skill with small or large units is related to letter reading ability, and this effect is independent of age, schooling, and cognitive ability. Some PA tasks are performed above chance levels by children who cannot recognise single letters.

Conclusions: Basic PA develops prior to the attainment of literacy, and learning to read improves PA both quantitatively and qualitatively.

We don't have language at our house: Disentangling the relationship between phonological awareness, schooling, and literacy

Phonological awareness (PA) is a metalinguistic skill, which has been defined as the ability to reflect on phonological properties of words (Hatcher, Hulme, & Ellis, 1994); it is usually taken to include some or all of: the ability to see similarities between words, including selecting or generating words that rhyme or share a common onset; the ability to manipulate words including forming new words from blends of other words and segment words into their constituent components (phonemes, syllables); and the awareness of the component parts of words including phonemes and syllables. The ability to perform tasks of this type has been widely associated with reading ability, both in typically developing beginning readers, and in children with poor reading skills (see, for example, Goswami & Bryant, 1990).

Recent debate has centred around the association between these two sets of skills – literacy skills and PA skills. Castles & Coltheart (2004) provide an exhaustive review of correlational and experimental studies examining the link between the two. They examine two hypotheses that have been proposed to explain this link: either that earlier PA contributes to later literacy skill (Goswami & Bryant, 1992), possibly for example through the ability to form analogies about words and parts of words; or that earlier literacy skill contributes to later PA skill (Adrian, Alegria, & Morais, 1995), so that individuals who have not learned to read will have inferior PA skills.

However, as Castles & Coltheart point out, it is difficult to conclude definitively that there is influence between reading and PA in one direction or another. They propose two tests that might distinguish between these two hypotheses. Firstly, if training in PA leads to improvement in reading skill, this might indicate that earlier PA contributes to later literacy skill. Results of training studies have, however, been equivocal, especially when only those studies are considered that have trained some children on awareness of phonemes without also training them on literacy skills (Bus & van IJzendoorn, 1999; Castles, Holmes, Neath, & Kinoshita, 2003).

Secondly, if PA can be shown to exist in individuals who have not yet learned any literacy skills, this would help discriminate between these two alternative theories. Again, relevant studies are difficult to find, since it is hard to measure PA in children who are young enough that they genuinely have no literacy skills, including no letter knowledge; moreover some studies (such as, for example, Bryant, Maclean, Bradley, & Crossland, 1990)fail to report initial literacy skills.

Where illiterate adults have been considered, it is difficult to determine whether these individuals have some underlying cognitive reason for their illiteracy, or whether it is simply due to economic or other personal circumstances, although PA has generally been found to be poor in these individuals (Adrian et al., 1995; Morais, Bertelson, Cary, & Alegria, 1986). Turning to individuals who are literate, but not in an alphabetic language, Read, Zhang, Nie & Ding (1986) found that adults who had learned to read only traditional Chinese orthography could not perform phoneme manipulation tasks but those who had learned *pinyin*, a Romanised Chinese orthography, could perform these tasks, even if they could no longer read *pinyin*. Both the work of Morais and colleagues and the work of Read and colleagues strongly suggests that aspects of PA, in particular explicit phoneme awareness, are not possible for those who cannot read an alphabetic language.

Castles and colleagues (Castles & Coltheart, 2004; Castles et al., 2003) therefore suggest an addition to the two theories (PA drives literacy versus literacy drives PA): once children learn to read, they carry out PA tasks in a qualitatively different way. After learning to read, individuals have both orthographic and phonological means available to perform PA tasks, while before learning to read only a phonological means is available. Evidence for this includes the strong influence of orthographic knowledge and level of orthographic skill on performance of, for example, phoneme deletion tasks (see below for a discussion of different aspects of PA) (Castles, Holmes, Neath, & Kinoshita, 2003).

Debate around these three alternative models of the link between PA and reading continues. Our study is an attempt to address this debate. As previous studies have found it hard to test PA in very young children who genuinely have no reading ability, it seems timely to examine phonological and phonemic awareness in children who can be shown to have no literacy skill, but who are old enough to be able to perform PA tasks. It is also helpful to carry out such a study in a community where years of education are not in one-to-one correspondence with age, so that literate and/or educated children can be compared with those who are not literate or not educated, but are the same age. Such communities exist throughout rural East Africa; our study site, in coastal Tanzania, is a monolingual Kiswahili-speaking area where education is also in Kiswahili, lending itself well to this type of research.

The structure of PA

We now address the nature of PA itself. Some authors hypothesise that PA is not a unitary ability – metalinguistic awareness of the phonological components of words can occur at a variety of levels of representation (McBride-Chang, 2004; Treiman & Zukowski, 1991). From small to large units, these can include representation of phoneme, syllable or whole word levels, as well as sub-syllable units such as onset and rime (Duncan, Seymour, & Hill, 1997). There is ongoing debate about which levels of representation are most important for literacy (Bryant, 1998;

Hulme, Muter, & Snowling, 1998; Muter, Hulme, & Snowling, 1998). It is therefore necessary to examine children's PA at each of these levels. Children who have not yet learned to read may have access to larger units but not to smaller units, and, in particular not to phonemes.

The type of response that a child is asked to make in PA tests may also affect their performance. McBride-Chang (2004) suggests that responses vary on a continuum from easy, more implicit speech perception tasks (such as same-different tasks) to hard, explicit speech manipulation tasks (such as word segmenting tasks). It has also been suggested (Goswami & East, 2000) that the difference between PA skill before and after learning to read is that children can have good implicit PA skills before they learn to read but it is only once they have learned to read that they have good explicit PA skills and can manipulate words.

Anthony and colleagues (Anthony & Lonigan, 2004; Anthony et al., 2002), however, suggest that while different aspects of PA may appear to develop at different times, implying that PA is in fact a set of skills rather than a unitary ability, this may be an artefact based on the varying difficulty of different types of PA tasks, which may therefore be performed at floor or ceiling level by one group of children or another, and hence in a factor analysis appear to represent a different factor to other skills. Their confirmatory factor analysis suggests that this ability is indeed a single skill, manifesting itself in different ways at different developmental time points.

PA examined cross-linguistically

It has been observed for some time that children learning to read some languages – particularly those that with more transparent orthographies – find the task easier than children learning to read standard English orthography (Alcock et al., 2000; Paulesu, 2006; Thorstad, 1991). This may be due to the easier task of decoding a shallow orthography, or to lexical structure. Most previously-researched languages which have shallow orthographies also have more open syllables and fewer consonant clusters than English[1]. Comparing studies across languages, however, seems to confirm the finding that children are aware of larger unit sizes – syllables – before they begin reading instruction, but explicit awareness of smaller unit sizes – phonemes – usually only reaches mature levels after reading instruction has commenced. Language structure appears to influence access to syllable structure; Ziegler and Goswami (2005) find that children learning to read languages with simple syllable structure (Turkish, Greek or Italian) have better syllable awareness than children learning to read languages with more complex syllable structure (English or French).

The languages discussed above also differ systematically in their orthographic depth, as noted – the languages with simpler phonological structure having shallower orthography. It is important to note that typically developing children learning to read phonologically complex languages with shallow orthography, such as German, appear to learn to read more rapidly than children learning to read English (Wimmer, 1996). In addition, in most languages children appear to have awareness of rimes before they gain awareness of onsets (Bradley & Bryant, 1983; Wimmer, Landerl, & Schneider, 1994) – but this could be related to the morphophonemic nature of the languages studied to date, since all the European languages which have been the subject of previous studies have word-final grammatical marking. It is important therefore to consider the word and syllable structure of Kiswahili before assessing children's performance on PA tasks.

Research setting

The study was carried out in coastal Tanzania. It is estimated that 65% of children of primary school age (7-13 years) in Tanzania are in school. Of these only 10% are in the correct grade for their age. However, many children start school late (Tanzania Ministry of Education and Culture, 2003). This means that more than 65% of children obtain at least some primary education, and many children in school are over the theoretical maximum age. In a related study (Jukes, Grigorenko, Alcock, Sternberg, & Bundy, under revision) parents were asked their reasons for children's non-enrolment at official age, and these included financial reasons, the distance to school, and the parents' assessment of a child's maturity or of the appropriateness of the official enrolment age, with interaction between these reasons common. It appears that children who do not attend school are not intrinsically different from children who do attend school.

The Kiswahili language

In the study area, children speak Kiswahili at home, which is also the language of school instruction. Kiswahili is an Eastern Bantu language with the characteristic agglutination of such languages, and with a large proportion of lexical borrowings from Arabic and also from English and some other European languages. It has a number of features relevant to the study design (Contini-Morava, 1997):

1. A relatively light phonological structure, with almost exclusively open syllables (ending in a vowel) and very few consonant clusters and very few one-syllable words. Words are hence primarily CVCV (or longer), VCV, or variations on this.
2. The dialect spoken in the study area has approximately 22 consonants (some speakers poorly distinguish some pairs of consonants that are much more distinct in other dialects), and five vowels. The consonants include plosive stops (all of which are unvoiced), implosive stops (all of which are voiced), both very common consonants, as well as voiced nasals, voiced and voiceless fricatives, two

affricates (one unvoiced and plosive, one voiced and implosive), one trill and three approximants. All consonants are legal in any syllable-initial position in the word, but some are more common in some positions because of grammatical features (see below).

3. The grammatical structure involves prefixes marking nouns, verbs or adjectives for grammatical noun class – see Contini-Morava (1996) for a fuller discussion of this concept in Kiswahili. Not all words begin with a prefix, but a very large number of words begin with the same prefixes, and several of these happen to start with the same phoneme (/m/); /k/ is also common. Several other consonants and most vowels are commonly found in grammatical word prefixes. Most of these prefixes are syllabic, mainly including a vowel although some are the syllabic consonant /m/. These features lead to a confound of grammatical similarity and phonological similarity, and a possible bias to attending to the start of a word by pre- and beginning-readers with grammatical knowledge.
4. In English, words that rhyme must have exactly the same phonological form from the vowel of the stressed syllable onwards – for example, "butter" and "stutter" rhyme, as do "recite" and "delight", while "recite" and "termite" do not rhyme because the stress patterns are different, and "butter" and "altar" do not rhyme though the final syllables are homophonous, because they have stress on the initial syllable, and that syllable is not the same from the vowel onwards. Rhymes are commonly used in English folk and children's songs.

   In Kiswahili, in contrast, words are almost exclusively emphasised on the penultimate syllable; the concept of rhyme exists, and is used in children's songs, folk songs, and poetry. Kiswahili rhyme involves only final syllable identity between the two words; this is known as *vina.* For example, the words *Dodoma* (the name of a town) and *homa* ("fever") are *vina*, but so is the word *sema* ("say), as the final syllable is the same, despite stress on the penultimate syllable. Only the first two would rhyme in English.

During piloting, tasks involving English-type rhyme were designed, and it was found that the adult research assistants working on the project were unable to generate or match English-type rhymes in Kiswahili at a level that would be expected of even preschool children whose first language is English. Generating and matching *vina*, however, was easy for adults and older children in the study area.

The phonological and grammatical structure of Kiswahili words, as described here, may lead to good awareness of syllables in pre-readers, like those studied previously who speak other languages with relatively simple syllable structure, such as Turkish, Greek, and Italian (Cossu, Shankweiler, Liberman, & Katz, 1988; Durgunoglu & Oney, 2002; Harris & Giannouli, 1999). Looking at onset awareness, it is possible that this could be better than that found in most European languages where grammatical affixes are primarily word-final (Ziegler & Goswami, 2005); however, the very simple nature of word and syllable onsets may lead to lower onset awareness than in some languages (Caravolas & Bruck, 1993).

Literacy and its development in Kiswahili

Literacy development in Kiswahili has been investigated previously (Alcock, 2005) and conforms to the normal pattern for development in regularly spelled languages, namely reading development which is rapid and all-or-none in character, and spelling development which is slower and requires a variety of phonological and orthographic knowledge. Literacy instruction in Tanzanian primary schools is very traditional in nature, with recitation of letters and words, and some sounding out and limited blending of syllables included in classes. Teaching methods also include whole-class repetition of a variety of other materials, such as vocabulary items.

The alphabet in Kiswahili consists of 24 letters (the English alphabet without X and Q, with CH representing /tʃ/, but without C as a single letter), and the names of these letters are /a/, /ba/, /tʃa/, /da/, etc. The letter name for all consonants starts with the phoneme relevant to that letter, while that for vowels consists of the vowel alone. Children are not explicitly taught the phonemes associated with letters, only the syllabic letter name.

Some children are taught to read before going to school. As these children are taught by siblings or other relatives who have been through the same schooling system, it is likely that they are taught using similar methods to those used in schools. A significant proportion of children not attending school can nonetheless read, while some of children attending school cannot yet read, so it is possible to separate the effects of literacy skill from those of school attendance.

In Western societies, written material surrounds children before they start school, even if they do not have books in the home. In rural Tanzania there are very few environmental or home literacy materials. Children in the study area are likely therefore to have exposure to print only from being taught to read by siblings or a teacher; pre-instructional print exposure will be minimal.

This study examines the influence of literacy experience and skill on PA using tasks at a variety of levels of representation (word to phoneme level) and a variety of levels of response (from odd-one-out tasks to word manipulation tasks). The PA skills to be tested include the widely used tasks of blending, segmenting, initial phoneme awareness, syllable and individual phoneme awareness, as well as pseudo-word repetition. As a conglomerate set of skills, the PA battery used in this study is very similar to that used in previous studies.

Hypotheses and summary

Following on from previous research, it is hypothesised that literacy ability (performance on reading tests) and, to a lesser extent, literacy training (attendance at school) will influence PA, but that some PA skill will develop before reading is initiated. It is further hypothesised that these effects will be independent of any effects of age, home environment, or cognitive skill. Finally it is hypothesised that letter reading skill will be more important for PA than word reading skill.

In summary, our study compares PA skills in children who are matched for age and who are attending or not attending primary school; in addition it examines reading skills, other language and cognitive skills, and home factors including parent attitudes and background, the material and physical state of the home, and the distance of the home from school.

Method

Subjects - Study design and participants

Families were recruited for the study through a household survey in three villages near Bagamoyo, Tanzania, with meetings held in each village with community leaders, parents and teachers. A census was taken of children in the relevant age group in each village. Each child's mother or female guardian also participated in the study. Parents or guardians gave informed consent, with oral explanations given both at meetings and one-to-one, and children gave assent to their participation. In total 54 boys and 54 girls took part in the study.

The design compared children who had never enrolled in school (i.e. with zero years of education), those in grade 1 and grade 2. To match children for age, equal numbers of children aged 7, 8, 9 and 10 years were randomly selected at each level of education (Table 1) . As can be seen from the Table, there are 11 groups – all age (7, 8, 9, or 10 years of age) by years of education (0, 1 or 2 years) combinations except for children aged seven in grade 2 - children do not reach grade 2 until they are eight years old. As far as possible, the study included 10 children in each group and the groups were gender balanced. Testing was carried out halfway through the school year. A total of 108 children were recruited to the study but three children did not complete the reading tasks.

[Table 1 about here]

Tasks

Children completed the following tasks, administered within one or two days of each other:

Phonological awareness tasks

Each task had two demonstration items. Children were then given four practice items until they could perform two items correctly, or until they had performed each practice item twice; a task was discontinued if children failed all practice items twice. Tasks were administered in the same order for each child, with no two tasks from one task group administered adjacently, and with a relatively easy task (repeating nonsense words) last, to avoid problems of fatigue and to provide an enjoyable final task. All tasks were designed and administered in Kiswahili. Other tasks (such as English-type rhyme) were piloted but discarded. The tasks are listed in order of the difficulty of response, but also varied on the size of the unit involved.

Easy response: "Odd one out" tasks. In these tasks, designed to measure implicit PA skills, children need not generate their own response. Children were introduced to a locally appropriate doll who liked to hear "words that were the same", and were encouraged to say which of three words the doll would not like. Three odd-one-out tasks were used: first sound (phoneme), first syllable, and final syllable (*vina*). Words used were balanced for overall phonemic similarity (number of shared phonemes) so that it was only possible to choose the odd one out based on the criteria being used, and not on overall phonemic similarity. There were 20 items in each task.

Intermediate response: Counting tasks. In these tasks, designed to be more explicit, children generate a response rather than repeating one of the stimuli, but the response itself does not require manipulation of the stimuli. Children were asked to count the number of words in a sentence, the number of syllables ("little parts of the word") in a word, and the number of phonemes ("sounds") in a word. These tasks were demonstrated using soda bottle tops, used in local games, as counting aids. Children were shown how to count the segments by moving the counters as the tester said the item. There were 12 items in each task.

Difficult response: Blending and segmenting tasks. In these tasks, designed to be highly explicit, children must generate a response that involves manipulating the words, syllables or phonemes in the stimuli. Children were shown how to form longer real words by blending two words, or pronounceable nonword syllables; for the segmenting tasks children formed real words by removing syllables or phonemes from longer real words. There were 12 items in each task. The blending task included word- and syllable-level items, while the segmenting task included syllable- and phoneme-level items. Seven items on the segmenting tasks required the child to remove a single phoneme from the word, of which four were single-phoneme syllables (vowels or syllabic consonants). Three items therefore required the deletion of single, non-syllabic phonemes.

Repeating nonsense words. Children repeated nonwords that were legal words in Kiswahili, ranging from two to five syllables in length. There were 40 test items. This subtest was originally developed for a separate study (Grigorenko, Ngorosho, Jukes, & Bundy, 2006).

Reading tasks

Children carried out a set of reading tasks which are described in Alcock et al. (2000); no standardised reading tests exist for Kiswahili or for this population. The tests comprise a letter decision task which involves deciding which letters are real letters and which are invented letters, and a word decision task which similarly requires children to discriminate between words and pseudowords. In both tests, children are asked to write a tick or a cross next to "real letters/words" and "silly letters/words" respectively. There are 12 real and 12 false letters or words respectively in each form of the test, with both the letter reading task and the word reading task having two parallel forms, hence using all 24 Kiswahili letters. The letter decision task was constructed so that no items resembled real letters rotated. Capital letters were used in order to eliminate some children's confusion between lower case letters that have reflectional symmetry with each other (such as b and d).

More detail can be found in the original study, but briefly, due to the regularly spelled nature of Kiswahili children can correctly read out loud words which are not in their lexicon. A lexical decision task in contrast requires that a word be either in children's visual lexicon, or for them to decode it and match it to their auditory lexicon, in order for them to correctly accept it as a word. Both letter and word decision tasks were rated for accuracy using the A' statistic[2]. An A' of greater than 0.75 indicates that the score is above chance.

Cognitive tasks

All children were given both Digit Span (a test of phonological working memory, correlating highly with verbal intelligence, and adapted from Wechsler, 1991) and a vocabulary test, developed to be appropriate for children up to the end of primary schooling. In the vocabulary test children were asked to choose a synonym/related word from a set of four alternatives including the target and a phonological and a distant semantic distractor, as well as an unrelated distractor. For example, children were asked: a chick (*kifaranga*) is a chigger (*funza)*? or a lock (*kifunguo)*? or a chicken (*kuku*)? or a t-shirt (*fulana)*? A subset of children (N = 48) were given Raven's Coloured Matrices (Raven, Court, & Raven, 1995), individually, as part of a related study (Jukes et al., under revision). None of these tests are standardised for this group, but were selected following extensive piloting, and as with the reading tests there are no standardised cognitive tests in existence locally. These tests therefore represent the best available tests for this population.

Other measures

For each child a parent or guardian was interviewed using interview schedules concerning their home and the child's education. These included questions and observations on the material circumstances of the home, the parents' education and occupation, and the parent's attitude to education and reason for educational decisions, including their decision to send or not send this child to school. Data were also collected on children's enrolment in school, and the direct distance of their home from school was measured using a GPS device.

Analysis

The analysis had two aims. The first aim was to describe the levels of phonological awareness amongst children who could and could not discriminate letters and/or words at above chance levels, and to examine the differential effects of age, schooling and ability to discriminate letters and/or words.

The second aim of the analysis was to determine which of age, schooling or reading discrimination performance was most closely associated with phonological awareness. The first stage of this analysis assessed the relationship between phonological awareness and each of these three predictor variables in three separate univariate regression equations. A final multivariate regression equation considered the impact of all three predictor variables on the outcome variable in order to understand which had the greatest influence on phonological awareness. In order to control for any codependency of independent variables and PA variables on other factors, family background, SES, and general cognitive ability variables were considered for inclusion in the multivariate analysis.

Results

Reading skill and performance on PA tasks

Significant numbers of children who were not attending school were found to perform on the letter and/or word decision tasks at levels significantly above chance (in other words, their A'[1] was higher than the 95% confidence limits of 0.75, the chance level of A'). These data are shown in Table 2.

[Table 2 about here]

This finding means that it is possible to analyse the effects of schooling and of literacy skills separately. References to "readers" therefore indicate those children who performed significantly above chance on either the letter or the word discrimination task. "Non-readers" did not perform significantly above chance on either task.

We now look at the performance of readers and non-readers, compared to chance levels on each test, calculated using the standard error of the binomial distribution. Table 3 shows scores for all children, and for readers and non-readers (see above) separately, on all tasks. The mean score for both readers and non-readers on each test for which a chance level could be calculated was significantly greater than chance, with the exception of the first syllable odd-one-out task for the non-readers.

[Table 3 about here]

Non-readers were significantly poorer at all PA tasks except counting syllables and counting sounds, and nonsense word repetition. For nonsense word repetition there may be a ceiling effect.

Although the maximum possible score on the segmenting task involving phonemes was only 3, none of the readers scored more than 1 item correct on this subtask. Of non-readers, 4.7% (2 children) got one item correct on this subtask, and of readers, 9.7% (6 children) got one item correct. It seems that explicit manipulation of phonemes within words is very hard for all of the children in the study.

Performance across levels of tasks and reading skill groups

Table 4 shows the results of ANOVAs examining three between-subjects effects, reading group, schooling, and age, and two within-subjects effects, on PA task performance. Small numbers of children were found in some cells, with very few younger children able to read, especially those not in school, so age was aggregated into two bands (7-8 years and 9-10 years). Ns can be seen in Table 2, lower level.

Two 2 by 2 by 2 (between) by 2 by 2 (within) ANOVAs hence compare proportion correct on word and syllable, counting and word manipulation tasks (ANOVA 1) and on syllable and phoneme, odd-one-out and counting tasks (ANOVA 2). Performance on the phoneme level word manipulation task was negatively skewed so could not be included in ANOVA 1; this is therefore analysed separately (below). There was no word level odd-one-out task administered, leaving only two levels of unit size in ANOVA 2.

It can be seen from Table 4 that in both ANOVAs non-readers performed more poorly than readers. Children in school performed more poorly than those out of school in ANOVA 1 but not ANOVA 2, and there was no main effect of age in either ANOVA.

In addition, there were main effects of unit size and of task difficulty in both ANOVAs. Tasks involving syllables were easier than tasks involving words, in ANOVA 1, and tasks involving phonemes were easier than tasks involving syllables, in ANOVA 2: both of these differences are in the opposite direction to that predicted. In ANOVA 1 tasks involving a more explicit judgement – word manipulation tasks – were harder, but the main effect of difficulty was in the opposite direction in ANOVA 2, where the more explicit counting task was easier than the odd-one-out task. The hypothesised levels of difficulty with respect to the ease or explicitness of the task were therefore partially confirmed: children had more success with counting than with either word manipulation or odd-one-out. However the hypothesised levels of difficulty with respect to unit size were not confirmed: children had more success with syllable-level tasks than word-level tasks and more success with phoneme-level tasks than syllable level tasks. The interactions observed in ANOVA 2 (see below) also suggest that for some pairs of tasks within this comparison, differences in difficulty are seen, but not for others.

Interactions with schooling were observed in ANOVA 1 between task difficulty and schooling ($F_{1,96} = 7.77$, $p = .006$, $\eta^2 = .07$; the more explicit tasks – word manipulation – were harder for unschooled children), and between unit size and age ($F_{1,96} = 6.31$, $p = .014$, $\eta^2 =.06$), with younger children showing a larger difference between word-level tasks and syllable level tasks.

Finally a within-subjects interaction was observed in both ANOVAs between task difficulty and unit size (1: $F_{1, 96} = 53.95$, $p < .001$, $\eta^2 = .36$; 2: $F_{1,97} = 59.24$, p

<.001, $\eta^2 = .38$). A greater difference between word and syllable tasks was found on counting tasks than on word manipulation tasks in ANOVA 1; in ANOVA 2, the hypothesised direction of difficulty was confirmed for phoneme level tasks, where the counting task was harder than the odd-one-out task, but the opposite difference was found for syllable level tasks, where the odd-one out tasks were harder than the counting task.

As scores on the phoneme segmenting task were strongly negatively skewed this task was analysed separately using non-parametric analyses. An effect of reading group was found (Mann-Whitney $U_{105} = 808.50$, $p = .001$), but no effects of schooling (Mann-Whitney $U_{105} = 1169.00$, $p > .05$) or age (Kruskal-Wallis Chi-$sq_3 = 1.94$, $p > .05$) were seen.

Figures 1 and 2 show the results of these ANOVAs: respectively the effects of unit size and difficulty level on proportion correct on individual tasks, and the effects of age, school enrolment and ability to discriminate letters and/or words on overall PA ability (which was calculated by summing the z-score for each individual PA task).

[Figures 1 and 2 about here]

[Table 4 about here]

Correlations with other factors

Correlational analyses revealed that none of mother's educational experience and attitudes, home environment factors, distance from school, or score on Ravens CPM had any significant relationship with any reading or phonological awareness variables. These cognitive and other factors were therefore excluded from further analyses. Age, years of schooling, letter and word reading, and vocabulary and Digit Span all had significant relationships with one or more phonological awareness variables, as did the father's educational level.

Regression analysis

Multiple linear regression analyses were initially carried out separately to examine the effects of age, schooling, and of the two reading variables (Models 1-3). Following this one multiple regression analysis of all four independent variables was carried out. Age, schooling and the two reading variables were entered in a first step and the two cognitive variables (vocabulary and Digit Span) and the environmental variable (father's education) were entered into the analysis together in a separate, second step (Model 4). The dependent variable examined was total z-score for all PA tasks. This Model hence shows the contributions of all of the variables of interest to PA.

There were effects on overall PA score of age, schooling, and letter reading. When these independent variables were considered together with cognitive and environmental variables, letter reading, Digit Span and vocabulary score remained as significant predictors for the majority of tasks.

These results can be seen in Table 5 which shows significance levels and standardised beta coefficients. Figure 2 also shows differences between age, schooling, and reading groups on the total z-score for the PA tasks.

[Table 5 about here]

Discussion

To summarise, we found performance on PA tasks at a variety of levels of response or size of unit to be related to the ability to perform our very simple letter reading task at above chance levels. This is consistent with our hypothesis that basic letter reading ability would influence PA. Analyses carried out (both ANOVA and multiple regression) reveal that the relationship between PA and reading remains significant after controlling for age and schooling, and that the relationship between age and PA is also non-significant after controlling for letter reading ability and schooling, as seen in regression analysis Model 4. Our study design was intended to avoid the one-to-one correspondence between age and schooling, and all of Models 1, 2 and 4 show much lower beta values for age than for schooling, suggesting that age is much less closely related to PA than schooling is. Nevertheless, since it was not possible to find children aged 7 who had two years of schooling, there was some relationship between age and schooling, so that the effect of age seen in Model 1 is likely due to its relationship with schooling.

The relationship between PA and letter reading is also not accounted for by the relationship between PA and verbal cognitive test performance (Digit Span or vocabulary), nor by family or environmental variables. As hypothesised, the relationship between word reading ability and PA is in addition no longer significant after controlling for the relationship between letter reading ability and PA.

As seen in the ANOVAs, the relationship between PA and reading ability also applies across the spectrum of levels of response – from those tasks requiring only implicit metalinguistic awareness, such as odd-one-out tasks, to those requiring explicit manipulation of words, such as blending and segmenting tasks. Finally it applies to different sizes of units, words, syllables and phonemes.

Castles & Coltheart (2004), suggest that a fuller characterisation of the relationship between PA and literacy might be that learning to read alters the way children carry out PA tasks. The pattern of a) better performance on most tasks as children learn to read, b) unique relationships between PA and literacy skill, but no unique relationship between age and PA provides confirmation for their hypothesis. Children who have not yet learned to read are capable of performing above chance on PA tasks, but the main predictor of performance is letter reading ability. Although the overall set of tasks represent a single factor, some of the tasks, but not others, appear impossible for non-readers, suggesting that they approach the overall set of tasks in a different way.

Illiteracy and PA

Previous studies of adult illiterates and those who have never learned to read an alphabetic language (Adrian et al., 1995; Morais et al., 1986; Read et al., 1986) have suggested that PA, and in particular phoneme awareness, only develops once an individual has learned to read. We found evidence for implicit PA and some evidence for more explicit PA in the children in our sample who had not yet learned to read letters – these children were able to perform some implicit (odd-one-out) tasks, as well as more explicit (counting) tasks, at above chance levels. Likewise, performance on word and syllable manipulation tasks by these non-readers was good. However their performance on the phoneme manipulation subtest was poor. This could be taken as supporting evidence for these studies from illiterate adults showing lack of phoneme awareness in non-readers. It should be noted here however that children who could read also had very poor performance on this most explicit phoneme awareness task. We may need to look for an alternative explanation.

In attempting to examine the link between PA and beginning reading ability, studies of young children have generally failed to include those who cannot yet read any letters, or have not reported basic letter reading skills. In addition, where very young, pre-reading children are studied, in the West these children are typically too young to be able to attempt many of the PA tasks commonly used. Our study, of older children who are nonetheless unable to read words or letters due to their lack of educational opportunity, is therefore important in resolving this issue.

If PA, and in particular, explicit phonemic awareness, develops before children are able to read, then this implies first that PA skill is developing as children grow older, which some authors suggest is due to neural maturation rather than in response to any external influence such as language input (Morton, 2005), and second that children who cannot yet read should be able to perform PA tasks at above chance levels. Our data speak differently to both points. As discussed above, any relationship seen between age and PA is no longer significant when controlling for other factors, especially reading ability, implying that PA is not improving purely due to maturation in the age range studied. However, children who could not read either letters or words were able to perform at above chance levels on some PA tasks. These included two phoneme level tasks (odd-one-out first sound, and counting phonemes). The first of these tasks requires a relatively implicit response type, but the second arguably may require a more explicit awareness of phonemes. The implication is therefore that some level of PA, including some phoneme awareness, develops before children learn to read, but that literacy acquisition is necessary for further development of PA.

Caution should be exercised, however, in concluding definitively that the children in this sample who cannot read letters but who are relatively old have explicit awareness of phonemes. Children, whether they could or could not read letters, all performed very poorly on the most explicit phoneme manipulation task, phoneme segmenting, although children who could read letters performed significantly better. In addition, the phoneme counting task, although relatively explicit, unfortunately lent itself to a variety of strategies, including an implicit "overall word length" strategy, where a guessing response is calibrated to the overall acoustic length of the word, and a slightly more explicit "syllable" strategy – out of 12 items, 8 had only two-phoneme syllables (unavoidable given the nature of the language). A child whose responses consisted exclusively of the number of syllables in the word, multiplied by two, would score significantly above chance.

Hence although it is possible to conclude from these data that children who cannot yet read even letters do have some phonological awareness, it is not possible to state conclusively that they have explicit phoneme awareness. Indeed, given the very low scores on phoneme segmenting by children who could read letters, it is even possible to suggest that children who can read letters may not yet develop explicit phoneme awareness. A clue as to these children's poor performance might be found in the literacy instruction methods used in Tanzanian primary schools. Children are not taught to segment words, nor are they taught the phonemes associated with letters. Rather, they are taught the Kiswahili letter names, which are either the vowel sound, or the consonant followed by /a/. We might therefore conclude that, for explicit phoneme awareness tasks such as phoneme segmentation, knowing how to read letters is a necessary, but not a sufficient, condition for success. For good performance on this task, children may need to have explicit instruction in similar word manipulations, such as is provided in many other school systems.

Cross-linguistic comparisons

Previous work in a variety of European languages suggested that in Kiswahili, as in other languages with a simple syllabic structure, children should be found to have good syllable awareness before learning to read. This was partly confirmed: children who could not read performed above chance levels on some syllable tasks, but not on the initial syllable odd-one-out task. Performance on the syllable blending task was poor for children who could read neither letters nor words, and significantly lower than children who could read.

Likewise previous studies in a variety of languages suggest that children whose language emphasises rimes (as Kiswahili does) may have superior awareness of rimes, as opposed to onsets. However, children whose language has a complex onset structure (unlike Kiswahili) may likewise have superior awareness of onsets. Given the emphasis on onsets but very simple onset structure in Kiswahili, it was hard at the outset to predict whether in this sample non-readers' onset awareness would be poorer than or better than their rime awareness. In fact, children who could not read performed above chance on both initial phoneme and on final syllable implicit PA tasks, but not significantly above chance on the initial syllable task, suggesting that these children have limited onset awareness.

However, the fact that any tasks involving English rhyme were too difficult for all children and had to be dropped from the battery, suggests that children's rime awareness as it would be defined in some other languages may be poor. It is likely we should in fact define word segments in different terms for different languages. The final syllable of a word which is stressed on the penultimate syllable is not a defined word segment in most classifications, yet this segment – the *vina* – is both crucial for Kiswahili poetry and readily accessible to pre-readers who speak Kiswahili.

Conclusions

Our study has carried out for the first time an important test in examining the relationship between phonological awareness and literacy: namely, the evaluation of PA skills in children who have genuinely not yet acquired even elementary letter knowledge, despite being old enough to achieve reasonable levels of performance in testing sessions. Our results point to PA and letter reading having a closer relationship than PA and age, word reading, or schooling, and also to the parallel development of PA and letter reading. Children who have not yet begun to learn to read are poorer than children who have learned to read on all types of PA tasks. The evidence suggests that basic literacy influences PA (both qualitatively and quantitatively), confirming the hypothesis of Castles & Coltheart (2004).

These data are nevertheless correlational, so it is possible of course that the direction of causality is the opposite: PA might be influencing very early literacy skills, such as letter recognition. Let us consider the implications of this possibility. If PA does lead to early literacy skills, our findings from children out of school are puzzling. The close relationship between PA and letter reading which we found would then suggest that children who are not receiving any education nevertheless develop letter reading skills in the absence of education, as a result of their maturing PA skills. It seems rather unlikely that children would be able to learn letter reading skills without instruction as a direct result of PA maturation. It is more plausible that these children are learning to read, in or out of school, and that this new skill drives the development of PA.

It is also possible that another factor influences variability in both reading ability, and PA. Candidates for this could be an environmental factor (either a home factor, a parental factor, or exposure to schooling) or a cognitive factor. No environmental factors have an independent relationship with PA when letter reading and cognitive ability have been controlled for.

Vocabulary and Digit Span have independent relationships with PA, even after letter reading and other variables have been controlled for. The relationship between PA and letter reading also remains, however – there is no evidence that the relationship between literacy development and PA is explained by variability in a third cognitive ability.

Previous studies have attempted to examine PA in children who are non-readers, but have on the whole looked at children who have some letter reading ability, or who live in a society where they are surrounded by environmental print, and have books in the home. The letter reading task used in this study requires the most elementary letter knowledge possible: children only need to recognise letters in order to be able to perform above chance level. This suggests that children who perform below chance level on the letter reading task are genuinely those who have zero letter reading ability.

Our data on family literacy and incidental print exposure suggest that out of school exposure to print is genuinely low. The level of ownership of literacy materials was found to be poor – 72% of families had no books at all in the home, including religious books, while 78% never buy a newspaper and only 12% buy one once or more per week. Written posters and advertisements are few and far between, as are place name signs.

When asking children about use of other local languages in the home, as part of study site selection, children were asked what language they speak at home. One child, having only heard the word "language" in association with school language lessons, replied 'we don't have language at our house'. These facts, taken together, make us confident that children who appear not to be able to read have in fact had no exposure to literacy materials.

In summary, there appears to be a very close relationship between letter reading and phonological awareness, closer than the relationships between age, schooling, or word reading and PA, and independent of any cognitive influences on PA. These findings suggest that there is some development of PA before reading acquisition but that PA requires literacy acquisition for further establishment. However, longitudinal studies of PA and literacy development, preferably in children who genuinely cannot read even single letters at the start of the study, are required to establish causality in this relationship.

Notes

[1] Seymour, Aro & Erskine (2003) classify European languages by orthographic depth and by syllabic complexity. Languages with several literacy studies to date mainly fall into the shallow-simple group (Finnish, Greek, Italian, Spanish). There are some languages classified as shallow-complex but with the exception of German, there has been little research to date on literacy acquisition in these languages, leaving available findings on shallow orthographies primarily only relevant to simple syllable structure.

[2] A', or A prime, is a measure of accuracy that allows for some degree of response bias, and is calculated using the formula $A' = 0.5 + (y - x) (1 + y - x) / 4y (1 - x)$, where x = proportion of hits and y = proportion of false alarms (Linebarger, Schwartz, & Saffran, 1983).

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Table 1

Design matrix showing number of children in each group

Educational level	Age 7	Age 8	Age 9	Age 10
No education	8	11	10	8
Grade 1	9	11	11	10
Grade 2	-	8	11	11

Table 2

Reading skill by years of education and age

		Years of education			Out of school by age band		In school by age band		Mean age (s.d.) for children able to recognise either letters or words
		0	1	2	7 - 8	9 - 10	7 - 8	9 - 10	
Able to recognise letters	No	26	24	6					
	Yes	10	16	23					
Able to recognise words	No	33	34	16					
	Yes	3	6	13					
Able to recognise either letters or words	No				13	10	11	9	8.47 (1.08)
	Yes				5	8	16	32	8.82 (1.00)
Total		36	40	29	18	18	27	41	

Table 3

Descriptive statistics for PA tasks, cognitive tasks. For PA tasks this shows firstly those who cannot discriminate either letters from non-letters or words from non-words at above chance levels [N = 43], secondly those who can [N = 62]), and finally all children. For other tasks means are shown for those who can and cannot discriminate. Chance levels are (odd-one-out tasks) the total number of items divided by 3 or(counting tasks) the total number of items divided by the total number of responses that were produced by at least 1% of children. It is not possible to calculate chance levels for tasks where no chance levels are reported.

Within each response level tasks are ordered from larger units to smaller units.

	Maximum possible score	Chance score (95% confidence interval)	Able to discriminate letters or words	Min - max score achieved	Mean (std. dev.)	Proportion performing significantly above chance	Internal reliability of test (Cronbach's Alpha)‡
Level of response: easy							
First syllable†	20	6.67 (4.6 to 8.8)	No	0 - 17	7.43 n.s. (3.15)	.33	
			Yes	4 - 20	11.47* (4.54)	.58	
			Both	0 - 20	9.39* (4.37)	.48	
Final syllable†	20	6.67 (4.6 to 8.8)	No	0 - 18	8.98* (3.44)	.58	

			Yes	5 - 20	12.29* (4.07)	.71	
			Both	0 - 20	10.59* (4.09)	.66	
			No	0 - 16	9.00* (3.73)	.52	
First sound†	20	6.67 (4.6 to 8.8)	Yes	5 - 18	11.98* (3.31)	.76	
			Both	0 - 18	10.45* (3.82)	.66	
Level of response: medium							
			No	2 - 12	9.33* (1.83)	.88	
Counting words†	12	4 (1.75 to 6.25)	Yes	5 - 12	10.31* (2.10)	.95	.63
			Both	2 - 12	9.81* (2.51)	.94	
			No	1 - 12	9.91* (1.63)	.91	
Counting syllables n.s.	12	4 (1.75 to 6.25)	Yes	4 - 12	10.57* (2.15)	.97	
			Both	1 - 12	10.23* (1.63)	.93	
Counting sounds n.s.	12	4 (1.75 to	No	4 - 12	9.15* (1.98)	.93	.48

	6.25)	Yes	5 - 12	9.92* (1.84)	.92	
		Both	4 - 12	9.52* (4.08)	.93	
Level of response: difficult						
		No	0 - 10	4.06 (4.17)		
Blending†	10	Yes	0 - 10	7.45 (2.20)		.96
		Both	0 - 10	5.70 (2.14)		
		No	0 - 5	1.69 (2.31)		
Blending words†	5	Yes	0 - 5	3.33 (2.23)		
		Both	0 - 5	2.49 (1.56)		
		No	0 - 5	2.41 (2.12)		
Blending syllables†	5	Yes	0 - 5	4.18 (3.41)		
		Both	0 - 5	3.26 (3.32)		
Segmenting†	10	No	0 - 10	3.44 (3.74)		.90

			Yes	0 - 10	6.73 (1.55)
			Both	0 - 10	5.04 (1.56)
			No	0 - 5	1.56 (1.73)
Syllable segmenting†	9		Yes	0 - 5	3.08 (.19)
			Both	0 - 5	2.30 (.33)
			No	0 - 1	.04 (.27)
Phoneme segmenting†	3		Yes	0 - 1	.12 (3.61)
			Both	0 - 1	.08 (2.67)
			No	22 - 40	34.63 (3.2)3
Nonsense word repetition n.s.	40		Yes	27 - 40	35.80 (3.15)
			Both	22 - 40	35.20 (4.54)
Vocabulary score†	60	15	No	7 - 46	25.36 (7.90)

	Yes	11 - 46	28.90 (7.81)
Digit span† 27	No	2 - 9	4.93 (1.80)
	Yes	3 - 12	5.97 (2.03)
Raven's Coloured Matrices n.s.	No	0 - 21	14.04 (6.55)
	Yes	0 - 21	16.11 (5.09)

* Score is significantly above chance, p < .05

† Reading group means are significantly different from each other, p < .05.

‡Individual item scores were available for some tests only, due to test administration considerations.

n.s. Score is not significantly above chance or group means are not significantly different from each other.

Table 4

Analysis of variance, showing main effects and examining size of unit by level of difficulty 1) comparing word and syllable unit sizes in counting and word manipulation tasks 2) comparing syllable and phoneme unit sizes in odd-one-out and counting tasks. Interactions are discussed in the text.

Main effect	ANOVA 1 main effect				ANOVA 2 main effect			
	d.f.	F	p	η^2	d.f.	F	p	η^2
Within subjects effects								
Unit size	1,96	184.64	<.001	.66	1,97	9.04	.003	.09
Difficulty level of task	1,96	29.80	<.001	.24	1,97	7.75	.006	.07
Between subjects effects								
Reading group*	1,96	3.52	>.05	.04	1,97	6.50	.012	.06
Schooling	1,96	7.62	.007	.07	1,97	2.55	>.05	.03
Age group	1,96	1.30	>.05	.01	1,97	1.76	>.05	.02

*Reading group refers to discrimination of letters or words from non-letters or non-words (or both) at above versus below chance levels.

Table 5

Regression analyses with the dependent variable of overall phonological awareness: Models 1, 2 and 3 showing the separate impacts of age, schooling, and performance on reading tests followed by Model 4 showing the impacts of age, schooling, and performance on reading tests (step 1) with vocabulary, Digit Span and father's educational level (step 2) (N=105).

Model 1: Age alone			Model 2: Schooling alone			Model 3: Reading tests alone			
B	SE B	β	B	SE B	β	Variable	B	SE B	β
1.26	.56	.21*	4.48	1.19	.35***	Letter reading	6.59	2.10	.30**
						Word reading	2.31	1.63	.14 n.s.

Model 4				
		B	SE B	β
Step 1 (R^2 = .23***)	Age	.43	.56	.08 n.s.
	Schooling	2.94	1.20	.25*
	Letter reading	8.46	2.64	.33**
	Word reading	.48	1.49	.03 n.s.
Step 2 (ΔR^2 = .30***)	Age	.18	.48	.03 n.s.
	Schooling	1.83	.98	.15 n.s.
	Letter reading	5.48	2.16	.21*
	Word reading	-.90	1.25	-.06 n.s.
	Vocabulary	.14	.06	.19*
	Digit span	1.50	.24	.51***

Father's educational level	.11	.49	.02 n.s.

Note: * p<.05; ** p <.01, *** p <= .001, n.s. not significant.

Figure 1 – Proportion correct on PA tasks by unit size and task difficulty

Figure 2 – Total z-score for PA tasks by age, schooling, and reading group

Figure 1

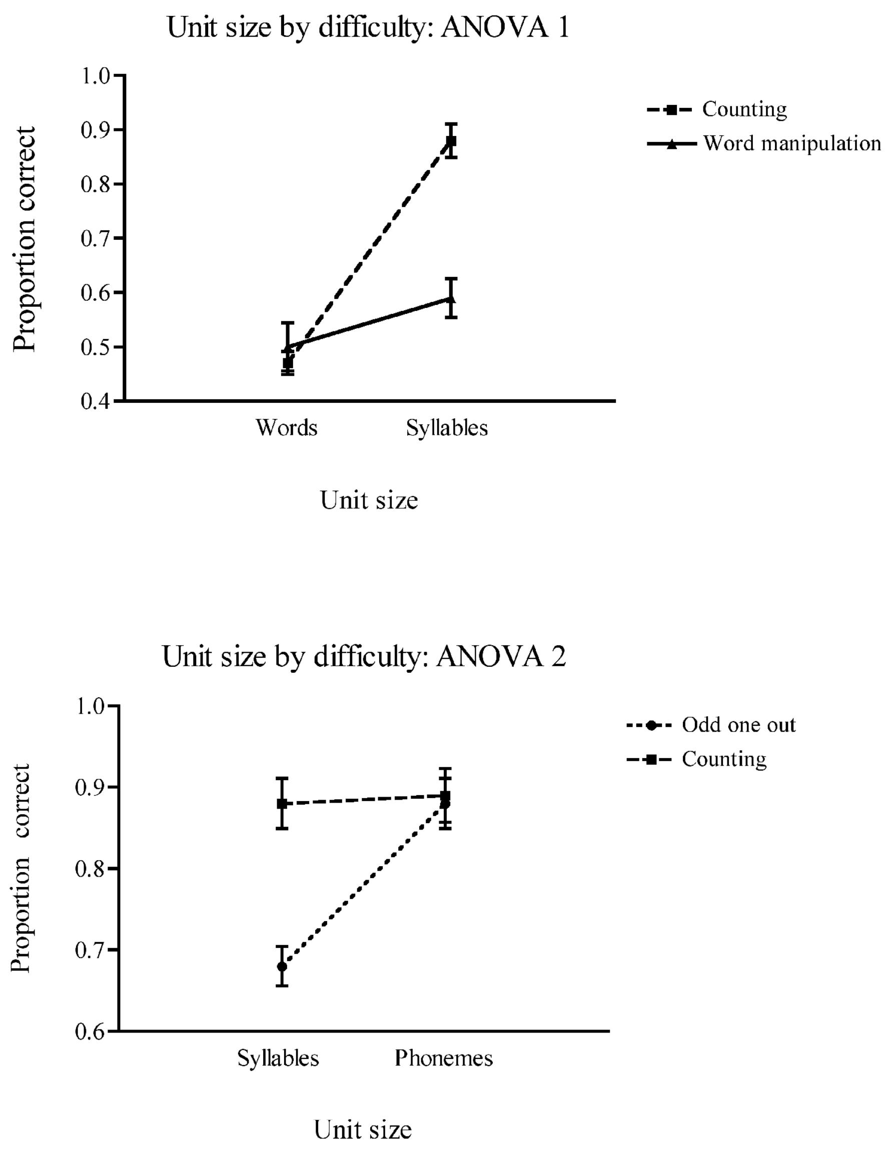
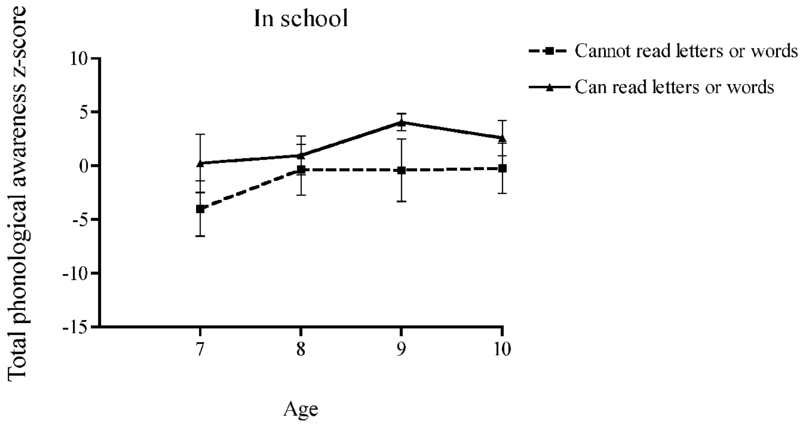
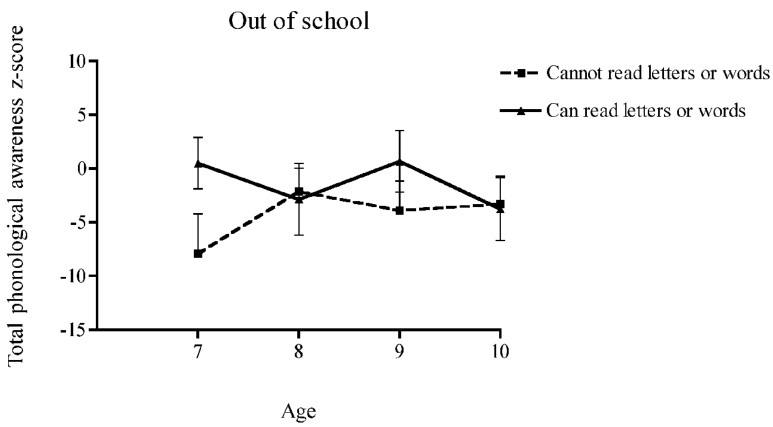

Unit size by difficulty: ANOVA 1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
Proportion correct
Counting
Word manipulation
Words
Syllables
Unit size
Unit size by difficulty: ANOVA 2
1.0
0.9
0.8
0.7
0.6
Proportion correct
Odd one out
Counting
Syllables
Phonemes
Unit size

Figure 2


In school
Total phonological awareness z-score
10
5
0
-5
-10
-15
7
8
9
10
Age
Cannot read letters or words
Can read letters or words


Out of school
Total phonological awareness z-score
10
5
0
-5
-10
-15
7
8
9
10
Age
Cannot read letters or words
Can read letters or words